

Ground Operations Demonstration Unit for Liquid Hydrogen (GODU LH2)

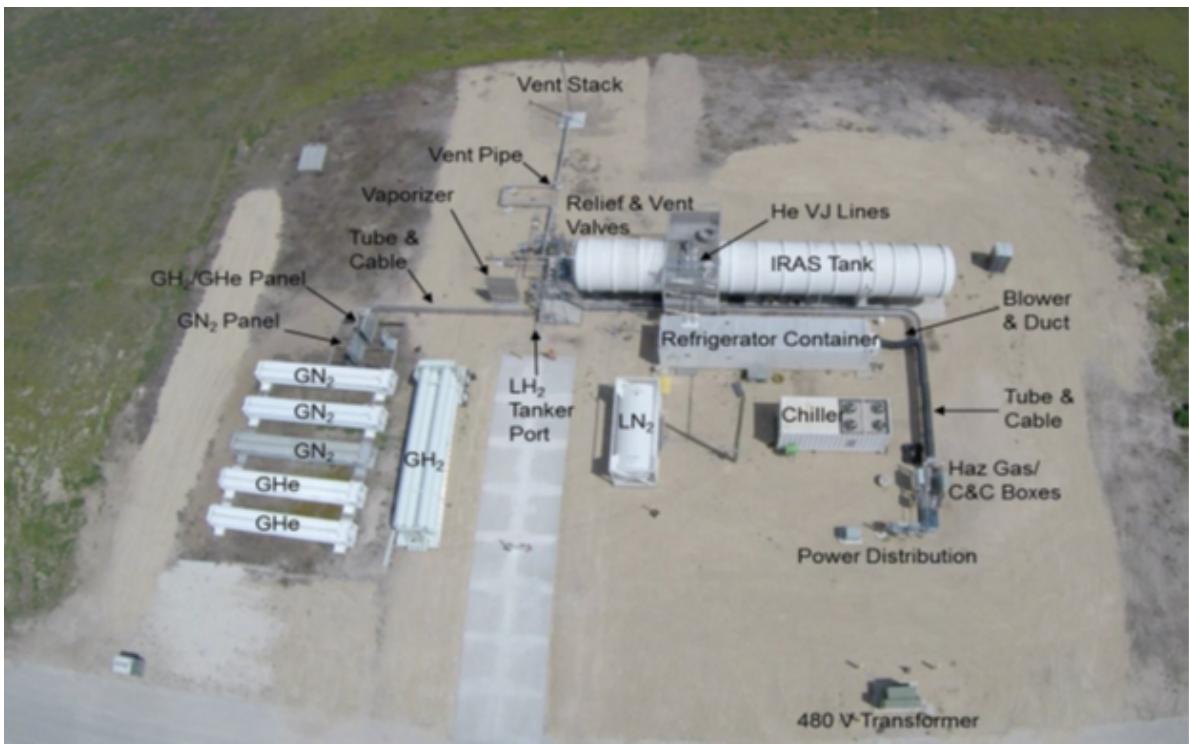
Description

The goal of the GODU LH2 project is to demonstrate advanced operational concepts that will reduce liquid hydrogen losses and increase ground control of cryogenic propellants in support of launch vehicles. Past data from the Shuttle program at both KSC and SSC shows approximately 50% of the LH2 purchased is lost thru venting and chill down. This project hopes to increase this efficiency to 80%. The key technology is the integration of a cryogenic refrigerator into the storage tank. Currently the system has losses from tanker offloads, normal daily boil off, and chill down of the cross country lines, but the GODU LH2 systems can eliminate all these losses. In addition to zero loss storage and transfer, in situ liquefaction will be demonstrated to allow for local production of propellant. Finally, densification of the LH2 will be accomplished in the storage tank. Past studies show LH2 densification can increase the overall launch vehicle ascent performance by up to 10%.

Success Story

The GODU LH2 project achieved its FY15 Milestone in May. The storage tank was chilled down to 20K using the integrated refrigeration system. This zero loss chill down is especially useful for ISRU based cryogenic systems where chill down of storage tanks can result in major product losses. Next, a 12,000 gallon tanker was offloaded into the tank, and the refrigeration system controlled the tank pressure by removing the heat leak as well as energy from the incoming liquid. Typically, KSC loses 13% of delivered product in tanker offload inefficiencies. Over the next three months, full zero boil off control of this propellant in the storage tank was achieved using several different control schemes. Typical daily boil off losses at LC 39 resulted in loss of another 12% of the total hydrogen procured. The GODU LH2 system is early in the test sequence, future testing in FY15 and FY16 will include liquefaction and densification.

NASA Success Story



Arial view of the GODU LH2 test area

Benefit

When the technology associated with zero loss storage and transfer is implemented, NASA can reduce the LH₂ losses and procurement costs by up to 30% compared to historical Shuttle numbers. This return on investment is based on the mission manifest and commodity use. LH₂ densification can provide improved launch vehicle ascent performance by minimizing the size of the LH₂ tanks or storing more mass of propellant in the given tank volume.

Technology goals of the GODU LH₂ project are also directly applicable to the In Situ Resource Utilization effort. Once propellants are produced in space, they will need to be liquefied and controlled prior to use. The GODU LH₂ integrated refrigeration concept will allow for zero loss storage and transfer of ISRU cryogenic systems as well as liquefaction of the produced gasses. In addition, hydrogen densification has the potential to increase the payload performance of the Atlas V and Delta IV rockets, allowing the Space Science Directorate to launch larger payloads on given launch vehicles.

The GODU LH₂ test area shown above is also available as a capability to perform further hydrogen energy related work.

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